Factors Affecting Operative Duration in Isolated Open Carpal Tunnel Release

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Abstract

Background Open carpal tunnel release (CTR) is one of the most commonly performed operative procedures with operative duration being a primary metric of operating room efficiency. The purpose of this study was to identify factors associated with prolonged operative duration, in performing CTR.

Materials and Methods CTR cases performed by a single surgeon from September 2013 to October 2015 were reviewed. Patient age at the time of surgery, sex, location of surgery (specialty orthopaedic hospital versus ambulatory surgery center), body mass index (BMI), American Society of Anesthesiologists classification, total operative duration (TOD), and procedure time (PT) were recorded. Obesity was defined as BMI $>$ 30 and morbid obesity was defined as BMI $>$ 35. Data were analyzed to identify factors associated with prolonged TOD or PT.

Results One hundred and nine consecutive patients underwent isolated CTR. Mean age at time of surgery was 62 years (range: 24–92 years). Nonobese patients were found to have significantly shorter TOD than obese patients (22.3 vs. 24.4 minutes). Similarly, patients who were not morbidly obese had significantly shorter TOD than morbidly obese patients (22.6 vs. 26 minutes). No other factors were associated with prolonged TOD. No difference in PT was found between normal weight, obese, and morbidly obese groups.

Conclusions TOD, but not procedure time, is significantly affected by obesity. Our findings are relevant when scheduling and preparing obese patients for surgery, which may have a significant impact on health resource utilization.

Level of Evidence This is a Level III, economic/decision analysis study.

Keywords
- carpal tunnel release
- efficiency
- obesity
- operating duration
- risk factors

Carpal tunnel release (CTR) is one of the most commonly performed operative procedures.[1–3] Nearly 500,000 CTR cases are performed every year, with the incidence predicted to increase.[4] Operative duration is a primary metric of operating room (OR) efficiency, with much attention recently given to maximizing OR capacity.[5–7] Improvements in the efficiency of operative room utilization can have a considerable effect on hospital operational costs, both in terms of staffing and finances.[8] Specifically, improved efficiency will allow hand surgeons to maximize their operative volume and help to improve hospital productivity.

The objective of this study was to identify factors associated with prolonged operative duration in performing CTR. We hypothesized that obesity was significantly associated with increased operative duration. Identification of factors associated with increased operative duration will allow for focused efforts to improve the efficiency of OR utilization.

Materials and Methods

Electronic medical records were reviewed for patients, who underwent isolated open CTR by a single surgeon from

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September 2013 to October 2015 after obtaining institutional review board approval. Open CTR was performed by making a small incision in-line with the thenar crease using a no. 15 scalpel blade. Blunt dissection was performed using curved tenotomy scissors and the palmar fascia was divided sharply in line with the skin incision. The transverse carpal ligament was then transected with a fresh no. 15 scalpel blade.

Patients aged 18 years and older were included. Patient age at the time of surgery, sex, location of surgery (specialty orthopaedic hospital versus ambulatory surgery center [ASC]), body mass index (BMI), American Society of Anesthesiologists (ASA) classification, total operative duration (TOD), and procedure time (PT) were recorded. Obesity was defined as BMI > 30 and morbid obesity was defined as BMI > 35.[9] TOD was defined as the duration of time from when the patient entered the OR until the patient exited the OR. PT was defined as the duration of time from incision to procedure end time. Percentage of PT accounting for TOD was calculated as PT/TOD. Cases were performed under sedation with local anesthetics.

Comparisons between geriatric (aged ≥ 65 years) versus nongeriatric patients, females versus males, nonobese versus obese patients, nonmorbidly obese versus morbidly obese patients, ASA I versus ASA II–II, ASA I–II versus ASA III, and specialty orthopaedic hospital versus ASC in terms of TOD, PT, and percentage of PT, accounting for TOD were analyzed. Student *t*-tests were used for analysis of normally distributed continuous data. Statistical analyses were performed using Microsoft Excel (Redmond, WA). A p value < 0.05 indicated statistical significance.

Results

During the study period, 109 consecutive patients underwent isolated CTR. Mean age at time of surgery was 62 years (range: 24–92). Mean follow-up was 2.7 years (range: 1.7–3.8 years). Of the 109 patients, 72% (78/109) were female and 28% (31/109) were male. Mean TOD and PT were 23.1 minutes (range: 13–38 minutes) and 8.8 minutes (range: 3–19 minutes), respectively. Mean percentage of PT accounting for TOD was 38% (range: 12–58%). There were no infections or wound complications.

Nonobese patients were found to have significantly shorter TOD than obese patients (22.3 vs. 24.4 minutes; $p = 0.008$). Similarly, patients who were not morbidly obese had significantly shorter TOD than morbidly obese patients (22.6 vs. 26 minutes; $p = 0.002$). No significant differences in TOD were found when comparing geriatric versus nongeriatric patients, females versus males, ASA I versus ASA II–II, ASA I–II versus ASA III, or surgery performed in a specialty orthopedic hospital versus ASC. Comparisons in TOD are summarized in ►**Table 1**.

Patients who underwent CTR in a specialty orthopaedic hospital demonstrated significantly shorter PT than patients in an ASC (7.4 vs. 9.5 minutes; $p < 0.001$). PT accounted for a significantly smaller percentage of TOD among patients who underwent CTR in a specialty orthopedic hospital compared with patients in an ASC (31 vs. 41% minutes; $p < 0.001$). No significant differences in both PT and percentage of PT, accounting for TOD were found, when comparing geriatric versus nongeriatric patients, females versus males, nonobese versus obese patients, nonmorbidly obese versus morbidly obese patients, ASA I versus ASA II–II, or ASA I–II versus ASA III. Comparisons in PT and percentage of PT accounting for TOD are summarized in ►**Tables 2** and **3**, respectively.

Table 1 Comparison of total operative duration

	n	Total operative duration (min), (SD)	*p*-Value
Age			
$<$ 65 years	65	23.2 (4.2)	0.729
$\geq$ 65 years	44	23 (3.5)	
Sex			
Female	78	23 (4.2)	0.724
Male	31	23.3 (3.3)	
Obesity			
BMI $<$ 30	68	22.3 (3.5)	0.008
BMI $\geq$ 30	41	24.4 (4.2)	
Morbid Obesity			
BMI $<$ 35	94	22.6 (3.6)	0.002
BMI $\geq$ 35	15	26 (4.6)	
ASA I			
I	21	23.2 (3.2)	0.918
II and III	88	23.1 (4.1)	
ASA II			
I and II	86	23.1 (3.8)	0.783
III	23	23.3 (4.6)	
Location			
Hospital	36	23.6 (4.6)	0.353
ASC	73	22.9 (3.5)	

Abbreviations: ASC, ambulatory surgical center; ASA, American Society of Anesthesiologists classification; BMI, body mass index; SD, standard deviation.

Discussion

The objective of this study was to identify factors associated with longer operative duration in performing CTR. According to our hypothesis, obesity is significantly associated with increased operative duration that was supported by our findings. A statistically significant increase in TOD for isolated open CTR was associated with both obesity and morbid obesity. However, no association between PT and obesity or morbid obesity was noted. These findings suggest that inefficiencies in performing CTR in obese patients occur during OR setup, as well as patient positioning and prepping, not during the actual surgical procedure.

The increased operative time associated with obese patients undergoing surgery is an important finding as patient scheduling and health resource utilization may be affected.[10] Although mean increase in TOD was 2 and 4 minutes for obese and morbidly obese patients, respectively, case order and

Table 2 Comparison of procedure time

	n	Procedure time (min), (SD)	*p*-Value
Age, (SD)			
< 65 years	65	8.8 (3.1)	0.953
≥ 65 years	44	8.8 (2.6)	
Sex			
Female	78	8.9 (2.9)	0.596
Male	31	8.5 (2.8)	
Obesity, (SD)			
BMI < 30	68	8.8 (2.7)	0.947
BMI ≥ 30	41	8.8 (3.1)	
Morbid obesity, (SD)			
BMI < 35	94	8.7 (2.5)	0.368
BMI ≥ 35	15	9.4 (4.4)	
ASA I			
I	21	9.1 (2.6)	0.52
II and III	88	8.7 (2.9)	
ASA II			
I and II	86	8.8 (2.7)	0.73
III	23	8.6 (3.4)	
Location			
Hospital	36	7.4 (2.6)	< 0.001
ASC	73	9.5 (2.7)	

Abbreviations: ASC, ambulatory surgical center; ASA, American Society of Anesthesiologists classification; BMI, body mass index; SD, standard deviation.

Table 3 Comparison of percentage of procedure time accounting for total operative duration

	n	Percentage of procedure time in total operative duration	*p*-Value
Age, (SD)			
< 65 years	65	38	0.773
≥ 65 years	44	38	
Sex			
Female	78	39	0.379
Male	31	37	
obesity, (SD)			
BMI < 30	68	39	0.106
BMI ≥ 30	41	36	
Morbid obesity, (SD)			
BMI < 35	94	38	0.277
BMI ≥ 35	15	35	
ASA I			
I	21	40	0.401
II and III	88	38	
ASA II			
I and II	86	38	0.486
III	23	37	
Location			
Hospital	36	31	< 0.001
ASC	73	41	

Abbreviations: ASC, ambulatory surgical center; ASA, American Society of Anesthesiologists classification; BMI, body mass index; SD, standard deviation.

scheduling can be optimized for OR efficiency. Some strategies may include scheduling obese patients for first case in the first OR if a surgeon is able to run multiple rooms. In this way, obese patients may receive sedation and be properly positioned, prior to the surgeon scrubbing for the case.

More than one-third of the adult population in the United States is obese with the prevalence projected to increase to 51% by 2030.[9,11,12] While obesity has received considerable attention as a major public health concern, few studies in the orthopaedic literature have evaluated the association between operative duration and obesity. Gadinsky et al reviewed 454 primary total knee arthroplasty (TKA) cases and found significantly longer OR and surgery times among obese patients when compared with normal weight patients.[13] Wang et al assessed 425 primary total hip arthroplasty (THA) cases and reported that obese patients had greater total room time and surgery time than normal weight patients.[14] These findings are consistent with the results of the current study, which found a statistically significant increase in TOD among obese and morbidly obese patients.

Although, the current study did assess the frequency of complications, none were found to have occurred. The absence of complications in our study cohort precluded statistical analysis. However, prior studies have identified a relationship between surgical duration and increased risk of complications. Kim et al reviewed 4,588 single level lumbar fusion cases and found an increased incidence of surgical site infection, sepsis, wound dehiscence, venous thromboembolic events, and cases necessitating blood transfusions associated with increasing operative duration.[15] The authors recommend further identification of factors associated with prolonged operative duration and developing strategies to reduce operative duration to improved outcomes.

Interestingly, the percentage of PT, accounting for TOD demonstrated no association with obese and morbidly obese patients. This is likely due to the relatively small proportion of TOD accounted for by PT. PT only accounted for 38% of TOD for all cases. Thus, the efficiency of performing the procedure (i.e., PT) seems to be washed out by the inefficiency of operating room tasks, such as patient transfer, positioning, and prepping. Additionally, PT was significantly shorter, when CTR was performed at a specialty orthopaedic hospital instead of an ASC, despite having negligibly longer TOD. CTR in the specialty orthopaedic hospital took a mean 2.1 minutes, less than when

performed at an ASC. However, the specialty orthopaedic hospital was found to be significantly less efficient in performing CTR with only 31% of TOD being used for the actual procedure as compared with 41% in the ASC. The reasons for these findings are not clear. Sultan and Charalambous reviewed 41 orthopaedic cases performed over a 10 week period. They found that only 54% of OR time was used for the actual procedure with 12 and 9% of OR time used for positioning and draping, respectively.[16] Approaches to improve TOD efficiency for CTR may include having multiple pneumatic upper extremity tourniquet sizes available, as well as ensuring adequate staff and equipment for patient transfer. An intravenous line may also be inserted prior to the patient entering the OR.

Another interesting facet of obesity and CTR is the lack of reimbursement adjustment. Our study demonstrates a significant increase in TOD, when performing CTR among obese and morbidly obese patients. In discussing health resource utilization, Macario shared that mean cost of conducting an OR is $62 per minute.[17] This can be extrapolated to estimate an increase of $130 per obese patient and of $211 per morbidly obese patient undergoing CTR. Additionally, obese patients are noted to have increased risks of complications when undergoing CTR.[18] Despite this, the mean Medicare reimbursement for CTR is recently reported to be $295 with no adjustment for high risk or prolonged TOD patients.[19] Perhaps reimbursement adjustment for these patients may be warranted.

There are limitations to the current study. First, this study involves a single surgeon's experience. Thus, the generalizability of our results may be somewhat limited. Next, as this was a retrospective study, no validated outcome measurements were utilized. Our data and conclusions relied upon the accuracy of record keeping performed by OR staff. Last, post hoc power analysis revealed our study to be slightly underpowered. Group sample sizes of at least 64 patients were needed to achieve 80% power. However, the significant differences presented in our study were considerable and identified despite this limitation.

After conducting this study, the operative surgeon has transitioned to performing the majority of CTR surgeries utilizing a wide-awake hand surgery protocol. Such cases are performed without an anesthesiologist, without the insertion of an intravenous line, and without a pneumatic arm tourniquet. Such advancement has anecdotally improved the efficiency of the procedure and is an area of future investigation.

In conclusion, our study demonstrates that obesity prolongs TOD, but not PT in CTR. Additionally, CTR performed at an ASC is likely to be more efficient than if performed in a specialty orthopaedic hospital despite PT being longer. Our findings are relevant, when scheduling obese and morbidly patients for surgery and has an important impact on health resource utilization. Cost-utility analyses are needed to further explore the association between CTR and obese patients.

Note

This study was performed at the NYU Langone Orthopedic Hospital.

Funding

None.

Conflict of Interest

None declared.

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